CLAIMS

1. A heat regulating element comprising:

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an object subject to heat regulation by said heat regulating element and a circumferential gas flow path between said object and said fluid conduit.

2. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor; and

a heat regulating element comprising

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit.

3. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor;

a heat regulating element arranged about said rotary spindle and comprising

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit;

a liquid source coupled to said fluid conduit;

a temperature sensor coupled to said rotary spindle assembly; and

a controller coupled to said liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor.

4. A wafer processing assembly comprising:

a rotary spindle assembly comprising

a rotary drive motor,

a rotary spindle coupled to said rotary drive motor, and

a heat regulating element comprising a regulating element frame defining a fluid inlet, a fluid outlet, and a fluid conduit extending from said fluid inlet to said fluid outlet, wherein said fluid conduit defines a substantially cylindrical heat regulation void, and said heat regulation void defines an inside diameter selected to accommodate an outside diameter

of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing assembly.

5. A wafer processing assembly comprising:

a rotary spindle assembly comprising

a rotary drive motor,

a rotary spindle coupled to said rotary drive motor, and

a heat regulating element arranged about said rotary spindle and comprising a regulating element frame defining a fluid inlet, a fluid outlet, and a fluid conduit extending from said fluid inlet to said fluid outlet, wherein said fluid conduit defines a substantially cylindrical heat regulation void, and said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit;

a liquid source coupled to said fluid conduit;

a temperature sensor coupled to said rotary spindle assembly;

a controller coupled to said liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing

assembly, wherein dimensions of said circumferential gas flow path between said rotary spindle and said fluid conduit are selected to avoid substantial degradation of said exhaust gas flow profile.

6. A method for regulating heat generated by a rotary spindle assembly comprising inputting a temperature signal generated by a temperature sensor and controlling a liquid source as a function of said temperature signal, wherein said rotary spindle assembly comprises:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor;

a heat regulating element arranged about said rotary spindle and comprising

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit, wherein said liquid source is coupled to said fluid conduit, said temperature sensor is coupled to said rotary spindle assembly.

7. A method of processing a wafer in a wafer processing assembly comprising inputting a temperature signal generated by a temperature sensor, controlling a liquid source as a function of said temperature signal, and establishing dimensions of a circumferential gas flow path between a rotary spindle and a fluid conduit to avoid substantial

degradation of an exhaust gas flow profile, wherein said wafer processing assembly comprises:

a rotary spindle assembly comprising

a rotary drive motor,

said rotary spindle coupled to said rotary drive motor, and

a heat regulating element arranged about said rotary spindle and comprising a regulating element frame defining a fluid inlet, a fluid outlet, and said fluid conduit extending from said fluid inlet to said fluid outlet, wherein said fluid conduit defines a substantially cylindrical heat regulation void, and said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and said circumferential gas flow path between said rotary spindle and said fluid conduit, wherein said liquid source is coupled to said fluid conduit and said temperature sensor is coupled to said rotary spindle assembly;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining said exhaust gas flow profile of said wafer processing assembly.

8. A heat regulating flange comprising:

an upper surface;

a lower surface;

a flange body defined between said upper surface and said lower surface;

a passage extending through said flange body from said upper surface to said lower surface;

a fluid inlet;

a fluid outlet;

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet; and

a temperature sensor positioned in thermal communication with said flange body proximate said passage.

9. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor; and

a heat regulating flange secured to said rotary drive motor, said flange comprising

an upper surface,

a lower surface,

a flange body defined between said upper surface and said lower surface,

a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface,

a fluid inlet,

a fluid outlet,

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and

a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage.

10. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor;

a heat regulating flange secured to said rotary drive motor, said flange comprising

an upper surface,

a lower surface in contact with said rotary drive motor,

a flange body defined between said upper surface and said lower surface,

a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface,

a fluid inlet,

a fluid outlet,

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and

a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage;

a liquid source coupled to said fluid duct; and

a controller coupled to said liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor.

11. A wafer processing assembly comprising:

a rotary spindle assembly comprising

a rotary drive motor,

a rotary spindle coupled to said rotary drive motor, and

a heat regulating flange secured to said rotary drive motor, said flange comprising an upper surface, a lower surface, a flange body defined between said upper surface and said lower surface, a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface, a fluid inlet, a fluid outlet, a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and a temperature sensor

positioned in thermal communication with said flange body proximate said rotary spindle passage;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing assembly.

12. A wafer processing assembly comprising:

a rotary spindle assembly comprising

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor; and

a heat regulating flange secured to said rotary drive motor, said flange comprising an upper surface, a lower surface in contact with said rotary drive motor, a flange body defined between said upper surface and said lower surface, a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface, a fluid inlet, a fluid outlet, a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage;

a liquid source coupled to said fluid duct;

a controller coupled to said liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing assembly.

13. A method for regulating heat generated by a rotary spindle assembly comprising inputting a temperature signal generated by a temperature sensor and controlling a liquid source as a function of said temperature signal, wherein said rotary spindle assembly comprises:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor; and

a heat regulating flange secured to said rotary drive motor, said flange comprising

an upper surface,

a lower surface in contact with said rotary drive motor,

a flange body defined between said upper surface and said lower surface,

a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface,

a fluid inlet,

a fluid outlet,

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and

said temperature sensor is positioned in thermal communication with said flange body proximate said rotary spindle passage, wherein said liquid source is coupled to said fluid duct.

14. A method of processing a wafer in a wafer processing assembly comprising inputting a temperature signal generated by a temperature sensor and controlling a liquid source as a function of said temperature signal, wherein said wafer processing assembly comprises:

a rotary spindle assembly comprising

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor; and

a heat regulating flange secured to said rotary drive motor, said flange comprising an upper surface, a lower surface in contact with said rotary drive motor, a flange body defined between said upper surface and said lower surface, a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface, a fluid inlet, a fluid outlet, a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and said temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage, wherein said liquid source is coupled to said fluid duct;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing assembly.

15. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor;

a heat regulating element comprising

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit; and

a heat regulating flange secured to said rotary drive motor, said flange comprising

an upper surface,

a lower surface,

a flange body defined between said upper surface and said lower surface,

a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface,

a fluid inlet,

a fluid outlet,

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and

a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage.

16. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor;

a heat regulating element arranged about said rotary spindle and comprising

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit;

a heat regulating flange secured to said rotary drive motor, said flange comprising

an upper surface,

a lower surface in contact with said rotary drive motor,

a flange body defined between said upper surface and said lower surface,

a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface,

a fluid inlet,

a fluid outlet,

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and

a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage;

at least one liquid source coupled to said fluid conduit and said fluid duct; and

a controller coupled to said at least one liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor.

17. A wafer processing assembly comprising:

a rotary spindle assembly comprising

a rotary drive motor,

a rotary spindle coupled to said rotary drive motor,

a heat regulating element comprising a regulating element frame defining a fluid inlet, a fluid outlet, and a fluid conduit extending from said fluid inlet to said fluid outlet, wherein said fluid conduit defines a substantially cylindrical heat regulation void, and said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit, and

a heat regulating flange secured to said rotary drive motor, said flange comprising an upper surface, a lower surface, a flange body defined between said upper surface and said lower surface, a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface, a fluid inlet, a fluid outlet, a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing assembly.

18. A wafer processing assembly comprising:

a rotary spindle assembly comprising

a rotary drive motor,

a rotary spindle coupled to said rotary drive motor,

a heat regulating element arranged about said rotary spindle and comprising a regulating element frame defining a fluid inlet, a fluid outlet, and a fluid conduit extending from said fluid inlet to said fluid outlet, wherein said fluid conduit defines a substantially cylindrical heat regulation void, and said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit, and

a heat regulating flange secured to said rotary drive motor, said flange comprising an upper surface, a lower surface in contact with said rotary drive motor, a flange body defined between said upper surface and said lower surface, a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface, a fluid inlet, a fluid outlet, a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and a temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage;

at least one liquid source coupled to said fluid conduit and said fluid duct;

a controller coupled to said liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining an exhaust gas flow profile of said wafer processing assembly, wherein dimensions of said circumferential gas flow path between said rotary spindle and said fluid conduit are selected to avoid substantial degradation of said exhaust gas flow profile.

19. A method for regulating heat generated by a rotary spindle assembly comprising inputting a temperature signal generated by a temperature sensor and controlling at least one liquid source as a function of said temperature signal, wherein said rotary spindle assembly comprises:

a rotary drive motor;

a rotary spindle coupled to said rotary drive motor;

a heat regulating element arranged about said rotary spindle and comprising

a regulating element frame defining a fluid inlet and a fluid outlet; and

a fluid conduit extending from said fluid inlet to said fluid outlet, wherein

said fluid conduit defines a substantially cylindrical heat regulation void, and

said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and a circumferential gas flow path between said rotary spindle and said fluid conduit, wherein said liquid source is coupled to said fluid conduit; and

a heat regulating flange secured to said rotary drive motor, said flange comprising

an upper surface,

a lower surface in contact with said rotary drive motor,

a flange body defined between said upper surface and said lower surface,

a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface,

a fluid inlet,

a fluid outlet,

a fluid duct defined in said flange body and extending from said fluid inlet to said fluid outlet, and

said temperature sensor is positioned in thermal communication with said flange body proximate said rotary spindle passage, wherein said liquid source is coupled to said fluid duct.

20. A method of processing a wafer in a wafer processing assembly comprising inputting a temperature signal generated by a temperature sensor, controlling at least one liquid source as a function of said temperature signal, and establishing dimensions of a circumferential gas flow path between a rotary spindle and a fluid conduit to avoid substantial degradation of an exhaust gas flow profile, wherein said wafer processing assembly comprises:

a rotary spindle assembly comprising

a rotary drive motor,

said rotary spindle coupled to said rotary drive motor, and

a heat regulating element arranged about said rotary spindle and comprising a regulating element frame defining a fluid inlet, a fluid outlet, and said fluid conduit extending from said fluid inlet to said fluid outlet, wherein said fluid conduit defines a substantially cylindrical heat regulation void, and said heat regulation void defines an inside diameter selected to accommodate an outside diameter of said rotary spindle and said circumferential gas flow path between said rotary spindle and said fluid conduit, wherein said liquid source is coupled to said fluid conduit;

a heat regulating flange secured to said rotary drive motor, said flange comprising an upper surface, a lower surface in contact with said rotary drive motor, a flange body defined between said upper surface and said lower surface, a rotary spindle passage aligned about said rotary spindle and extending through said flange body from said upper surface to said lower surface, a fluid inlet, a fluid outlet, a fluid duct defined in said

flange body and extending from said fluid inlet to said fluid outlet, and said temperature sensor positioned in thermal communication with said flange body proximate said rotary spindle passage, wherein said liquid source is coupled to said fluid duct;

a wafer support secured to said rotary spindle so as to be rotatable therewith; and

a wafer processing bowl arranged about said wafer support, said wafer processing bowl defining said exhaust gas flow profile of said wafer processing assembly.

21. A heat regulating element as claimed in claim 1 wherein said heat regulating element frame further defines at least one gas intake port, and wherein said gas intake port is in communication with said circumferential gas flow path.

22. A heat regulating element as claimed in claim 1 wherein said regulating element frame comprises a body including a cylindrical cut-out, and wherein said fluid conduit is arranged about the periphery of said cylindrical cut-out.

23. A heat regulating element as claimed in claim 1 wherein said fluid conduit comprises a length of tubing.

24. A heat regulating element as claimed in claim 23 wherein said length of tubing is wound to define said substantially cylindrical heat regulation void.

25. A rotary spindle assembly as claimed in claim 2 wherein said rotary spindle comprises a cylindrical shaft.

26. A rotary spindle assembly as claimed in claim 2 wherein said rotary spindle assembly further comprises a ring chuck arranged to support said heat regulating element.

27. A rotary spindle assembly as claimed in claim 3 wherein said temperature sensor is positioned in said circumferential gas flow path.

28. A rotary spindle assembly as claimed in claim 3 wherein said temperature sensor is positioned to measure a temperature of liquid in said fluid conduit.

29. A rotary spindle assembly as claimed in claim 3 wherein said controller is programmed to alter a rate of flow of fluid through said fluid conduit in response to a temperature signal generated by said temperature sensor.

30. A rotary spindle assembly as claimed in claim 3 wherein said controller is programmed to alter a temperature of fluid in said fluid conduit in response to a temperature signal generated by said temperature sensor.

31. A heat regulating flange as claimed in claim 8 wherein said temperature sensor is embedded in said flange body.

32. A heat regulating flange as claimed in claim 8 wherein said fluid duct is arranged about said passage.

33. A rotary spindle assembly as claimed in claim 16 wherein said at least one liquid source comprises a single liquid source coupled to said fluid conduit and said fluid duct.

34. A rotary spindle assembly as claimed in claim 16 wherein said at least one liquid source comprises a first liquid source coupled to said fluid conduit and a second fluid source coupled to said fluid duct.

35. A rotary spindle assembly as claimed in claim 16 further comprising an additional temperature sensor coupled to said rotary spindle assembly, wherein said controller is coupled to said additional temperature sensor and is programmed to be responsive to a temperature signal generated by said additional temperature sensor.

5